CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The effectiveness of navigation and controls of an air vehicle are highly dependent on the degree of precision of the on-board inertial measurement unit (IMU) (Shiau, Huang and Chang, 2012). The IMU is a single unit in the electronics module which collects angular velocity and linear acceleration data which is sent to the main processor (IMU, http://www.ssl.umd.edu/projects/RangerNBV/thesis/2-4-1.htm, 2013). The sensors in the IMU are two rate gyros and three accelerometers. With perfect gyro measurements, the estimate of the orientation could be determined quite accurately; however, using real sensors, the error in the estimate grows with time due to quantization, integration, and sensor errors (Kim and Golnaraghit, 2004).

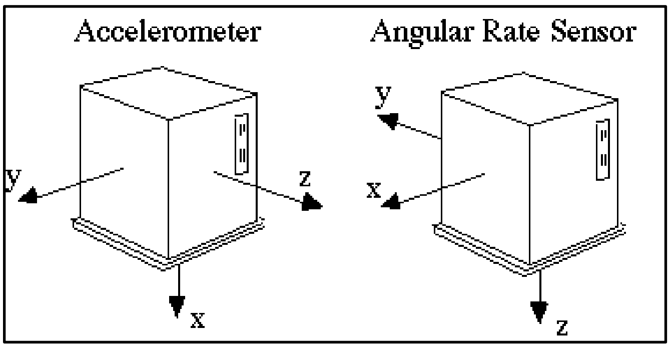

Figure 1.1: Initial IMU sensor coordinate axes [7]

An IMU works by detecting the current rate of acceleration, as well as it changes in rotational attributes, including pitch, roll and yaw. This data is then fed into a computer, which calculates the current speed and position, given a known initial speed and position (Hazry, Sofian, and Zul Azfar, 2012).

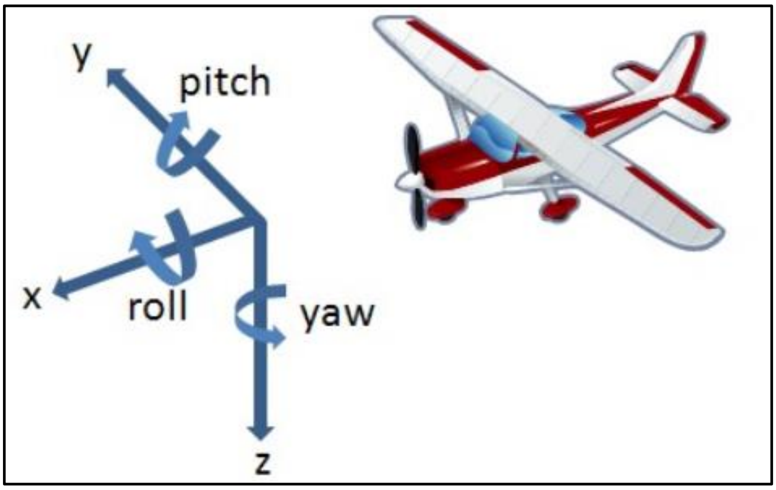

Figure 1.2: An IMU sensor measures linear acceleration and orientation [26]

IMU available in market now are in various types and shape. So, user can select what type, size and shape. The IMU can be selected from its degrees of freedom (DOF) that being developed by manufacturer. For five DOF, the sensors configurations are three accelerometers and two gyroscopes that measure pitch and roll.

1.2 PROBLEM STATEMENT

An inertial measurement unit, or IMU, is the main component of inertial guidance systems used in air space, and watercraft, including guided missiles. Driven by their low cost and small size, MEMS inertial sensors have been used to produce low cost INS that can be widely adopted in several navigation applications (Elkhidir, Shuhimi, Musa and Satti, 2011). An IMU works by sensing motion including the type, rate, and direction of that motion using a combination of accelerometers and gyroscopes (Hazry, Sofian and Zul Azfar, 2012). Therefore, the noise level at the output of MEMS-based inertial sensors must be reduced and the sensor errors separate from motion dynamics prior to processing their measurements by the KF module. One possible way of reducing high-frequency sensor noise is to use a low-pass filter. However, discrete low-pass filters result in inherent time delays when applied to system in real time, which could reduce the stability of the system (Angelosanto, 2008).

Low-pass filters also do not address the issues of inaccurate or unavailable measurements. In inertial navigation systems, two to three integrations are required to get from sensor outputs to a position solution. This is the major disadvantage of dead reckoning and inertial navigation; the fact that one or more integrations are required to convert sensor outputs to a position solution means that errors in sensor outputs lead to position errors that grow with time (Demoz Gebre-Egziabher, 2010). In this project, an inertial navigation system based on low-cost IMU sensor will be developed.

1.3 PROJECT OBJECTIVES

This project is intended to design and develop a data filtering of 5-axis IMU using Kalman Filter. The IMU use is low cost, high integrity and their board enables to easily incorporate roll, pitch, and tilt measurements for navigation application. The 5DOF-IMU data filtering is based on the Kalman filter method which is from a mathematical concept with a deep relationship with the foundations of algebra and number theory. In summary, the objectives of this project:

1. The main task of this project is to design and develop data filtering of 5-axis Inertial Measurement Unit (IMU) using Kalman Filter.

2. From all of the method used, verify the 5-axis inertial measurement unit can be filtered using Kalman Filter method.